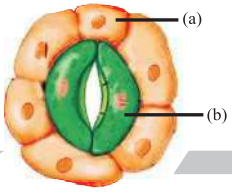


Chapter - 6

Anatomy of Flowering Plants

Points to Remember

Anatomy : Anatomy is the study of internal structure of organisms. Plant anatomy includes organisation and structure of tissues.

Tissue is a group of cells having a common origin and usually performing a common function.

There are two types of tissues (i) Meristematic (ii) Permanent

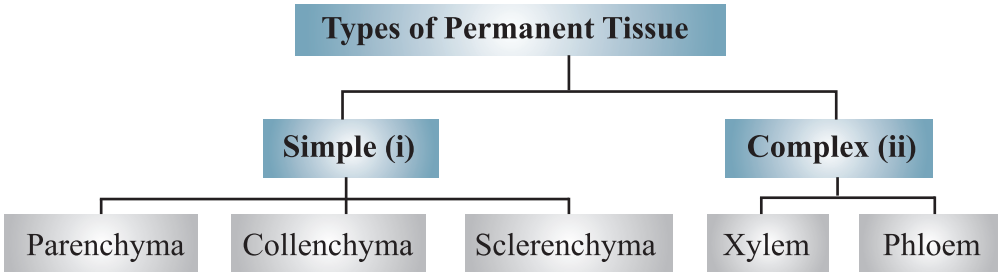
Meristematic tissues : The meristematic tissue is made up of the cells which have the capability to divide. Meristems in plants are restricted to specialised regions and responsible to the growth of plants.

Meristems

Apical meristem	Intercalary meristem	Lateral Meristem
• Occurs at the tips of roots and shoots	• Occurs between mature tissue	• Occurs in the mature region of roots and shoots
• Primary meristem	• Primary meristem	• Secondary meristem
• Increase the length of plant	• Occur in grasses and regenerate parts removed by grazers	• Appears later than primary meristem and responsible for secondary growth

Axillary bud : The buds which are present in the axils of leaves (Consist of cells left behind from shoot apical meristem) and are responsible for forming branches of flowers.

Permanent tissues : The permanent tissues are derived from meristematic tissue, are composed of cells, which have lost the ability to divide and have become structurally and functionally specialised.



Parenchyma : Living, thin walled isodiametric cells, with interceullar spaces, cell wall is made up of cellulose. It performs the functions like photosynthesis, storage, secretion.

Collenchyma : It is formed of living, closely packed cells. Its cells are thicknened at the corners due to depositon of celluose and pectin. It provide mechanical support to the growing parts of the plant. It is either found in homogenous layer or patches.

Sclerenchyma : It is formed of dead cells with thick and lignified walls. Provide mechanical support to organs. They have two types of cells : fibres and sclereids.

(a) Fibers—are thick walled,elongated and pointed cells.

(b) Sclereids—are spherical, oval or cylindrical, highly thickened dead cells with narrow lumen. Found in walls of nut, pulp of fruits like guava, seed coat of legumes and leaves of tea.

Xylem : Xylem consists of tracheids vessels, xylem fibres and xylem parenchyma. It conducts water and minerals from roots to other parts of plant.

(a) Tracheids—Tube like cells with thick and lignified walls and tapering ends; dead, without protoplasm.

(b) Vessel—long cylindrical structure made up of many cells with large central cavity, devoid of protoplasm. Present in angiosperms.

(c) Xylem fibres—highly thickened walls; with obliterated lumens; septate or aseptate.

(d) Xylem parenchyma—living and thin walled; cell walls made up cellulose, store food material in form of starch or fat.

Radial conduction of water takes place by ray parenchymatous cells

Protoxylem : The first formed primary xylem elements.

Metaxylem : The later formed primary xylem.

Endarch : Protoxylem lies towards the centre and metaxylem towards the periphery of the organ; in stem

Exarch : Protoxylem toward periphery and metaxylem towards centre; in roots.

Phloem : Phloem consists of sieve tube elements, companion cells, phloem fibres and phloem parenchyma; Phloem transports the food material from leaves to various parts of the plant.

(a) Sieve tube elements :

- long tube like structures arranged longitudinally.
- associated with companion cells.
- end walls are perforated to form sieve plates.
- functions of sieve tubes are controlled by the nucleus of companion cells.

(b) Companion cells

- Specialised parenchymatous cells associated with sieve tube elements
- Connected with sieve tube elements by pit fields present between their common longitudinal walls
- Help to maintain pressure gradient in sieve tubes.

(c) Phloem Parenchyma

- made up of elongated, tapering cylindrical cells with dense cytoplasm and nucleus.
- cell wall made of cellulose with pits through which plasmodesmatal connections exist between cells.
- store food material.

(d) Phloem fibers (bast fibers)

- are sclerenchymatous; absent in primary phloem but present in secondary phloem.
- elongated, unbranched pointed, needle like apices with thick cell walls.

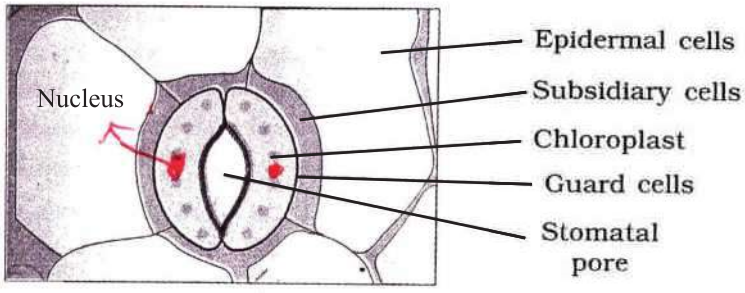
Protophloem : First formed phloem with narrow sieve tubes.

Metaphloem : Later formed phloem with bigger sieve tubes.

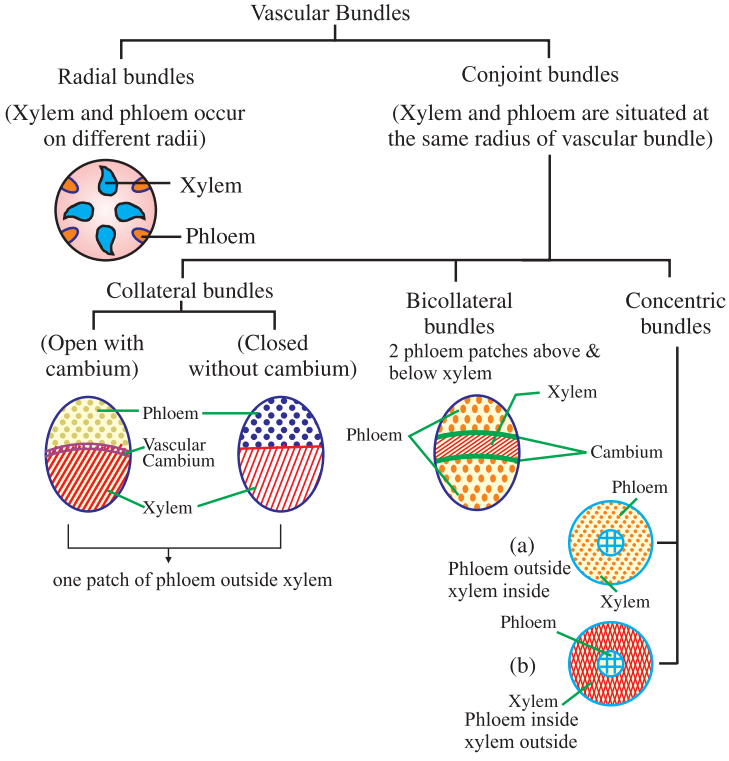
The Tissue System :

1. **Epidermal tissue system :** It includes:
   (a) Cuticle—Waxy thick layer outside epidermis, prevents the loss of water.
   (b) Epidermis : Outer most layer of primary plant body.
   (c) Epidermal hair : help in absorbing water and mineral from soil.
   (d) Trichomes : help in preventing water loss due to transpiration.
   (e) Stomata : Regulate process of transpiration and gaseous exchange.

Stomatal apparatus : The stomatal aperture, guard cells and surrounding subsidiary cells are together called stomatal apparatus.



2. **The ground tissue system :** It is made up of parenchyma, collenchyma, sclerenchyma. In dicot stems and both dicot and monocot roots the ground tissue is divided into hypodermis, cortex, endodermis, pericycle, medullary rays and pith.
3. **The vascular tissue system :** It includes vascular bundles which are made up of xylem and phloem.



Anatomy of Root

Dicot Root	Monocot Root
1. Cortex is comparatively narrow. 2. Endodermis is less thickened casparian strips are more prominent. 3. The xylem and phloem bundles varies from 2 to 5. 4. Pith is absent or very small. 5. Secondary growth takes place with the help of vascular cambium and cork cambium.	1. Cortex is very wide. 2. Endodermal cells are highly thickened casparian strips are visible only in young roots. 3. Xylem and phloem are more than 6 (polyarch). 4. Well developed pith is present. 5. Secondary growth is absent.

Casparian Strips—The tangential as well as radial walls of endodermal cells of dicot roots have deposition of, water impermeable, waxy material, suberin in the form of casparian strips.

Anatomy of Stem

Dicot Stem	Monocot Stem
1. The ground tissue is differentiated into cortex, endodermis, pericycle and pitch. 2. The vascular bundles are arranged in a ring. 3. Vascular bundles are open, without bundle sheath and wedge-shaped outline. 4. The stem shows secondary growth due to presence of cambium between xylem and phloem.	1. The ground tissue is made up of similar cells. 2. The vascular bundles are scattered throughout the ground tissue. 3. Vascular bundles are closed, surrounded by sclerenchymatous bundle sheath, oval or rounded in shape. 4. Secondary growth is absent.

Secondary growth dicot stem—An increase in the girth (diameter) in plants, vascular cambium and cork cambium (lateral meristems) are involved in secondary growth.

1. Formation of cambial ring : Intrafascicular cambium + interfascicular cambium.
2. Formation of secondary xylem and secondary phloem from cambial ring.
3. Formation of spring wood and autumn wood.
4. Development of cork cambium(phellogen)

Cork Cambium (Phellogen) — Cork (phellem) – From outer cells
Sec. cortex (phelloderm) – from inner cells

(Phellogen + Phellem + Phelloderm) = Periderm

Secondary growth in dicot roots : Secondary growth in dicot roots occur with the activity of secondary meristems (vascular cambium). This cambium is produced in the stele and cortex, and results in increasing the girth of dicot roots.

Anatomy of Leaf

Dorsiverntral (Dicot) Leaf	Isobilateral (monocot) Leaf
1. Stomata are absent or less abundant on the upper side.	1. The stomtata are equally distributed on both sides.
2. Mesophyll is differentiated into two parts upper palisade parenchyma and lower spongy parenchyma.	2. Mesophyll is undifferentiated.
3. Bundle sheath is single layered and formed of colourless cells.	3. Bundle sheath may be single or double layered.
4. Hypodermis of the mid-rib region, is collenchymatous.	4. Hypodermis of the mid-rib region is sclerenchymatous.
5. Stomata have kidney shaped guard cells.	5. Stomata have dumb bell shaped guard cells.

Spring Wood	Autumn Wood
1. Also called early wood.	1. Also called late wood
2. Cambium is active	2. Cambium less active
3. Xylary elements more	3. Xylary elements less
4. Vessels with wide cavities	4. Vessels narrow
5. Light in colour, low density	5. Dark, high denisty

Heartwood	Sapwood
1. Central or innermost region of stem which is hard, durable and resistant to attack of microorganisms and insects.	1. Peripheral region stem, light in colour
2. Not involved in conduction of water, gives mechanical support to stem	2. Involved in conduction of water and mineral

Lenticels—Produced when phellogen cuts off parchymatous cells on outer side. These cells rupture the epidermis forming lens shaped opening called lenticels.

Function—Permit exchange of gases.

Bulliform Cells—Large, empty, colourless adaxial cells with vein in leaves which maintain turgidity of leaves.

Questions

(SRT) Select Response Type Question (1 mark each)

1. Name the tissue represented by the jute fibers used for making ropes.
   (a) Parenchyma (b) Meristematic
   (c) Sclerenchyma (d) Aerenchyma
2. Which kind of wood is called early wood?
   (a) Spring wood (b) Autumn wood
   (c) Late wood (d) Delicate wood
3. Open vascular bundle is made of
   (a) Xylem & phloem (b) Xylem, cambium & phloem
   (c) Phloem only (d) Xylem only

CONSTRUCTED RESPONSE TYPE (CRT)

Very Short Answer Question (1 mark each)

4. State the role of pith in stem.
5. Where are bulliform cells found in leaves ?
6. Why are xylem and phloem called complex tissues ?
7. Which meristem is responsible for longitudinal growth in plants ?

8. What forms' the cambial ring in a dicot stem during the secondary growth?
9. Name the anatomical layer in the root from which the lateral branches of root originate.
10. Which tissue of the leaf contains chloroplast ?
11. A plant tissue when stained, showed the presence of hemicellulose and pectin in cell wall of its cells. Name the tissue.
12. Write the function of phloem parenchyma.
13. Name the cells which make the leaves curl in plants during water stress.
14. Give the function of lenticels.
15. The vascular bundles are surrounded by a thick layer of cells in leaves. What is the name of cells ?
16. Mention the signfiicance of casparian strips. Where do you find them ?
17. Give the function of companion cells.

Short Answer Questions (SA-I) (2 marks each)

18. Why is cambium considered to be lateral meristem ?
19. Give any four differences between tracheids and vessels.
20. How are open vascular bundles differ from closed vascular bundles ?
21. What are trichomes ? State their functions.
22. Given below are the various types of tissue and their functions. Which out of these is not a matching pair and why;

(a) Collenchyma :	provides mechanical support to the growing parts of plant.
(b) Sclerenchyma :	photosynthesis, storage and secretion.
(c) Chlorenchyma :	perform the function of photosynthesis
(d) Xylem :	conduction of water and minerals.

23. In which part of the plant you would see the following :

(a) Radial vascular bundle (b) Well developed pith

Short Answer Question (SA-II) (3 marks each)

24. Give the points of difference between lenticels and stomata.
25. Even being a monocotyledonous plant the Palm increases in girth. Why and how does it take place ?

26. Differentiate between endarch and exarch conditions.
27. If you are provided with microscopic preparation of transverse section of a meristemic tissue and permanent tissue, how would you distinguish them ?
28. Differentiate between aerenchyma and collenchyma on the basis of their structure and function.
29. Are there any tissue elements in phloem which are comparable to those of xylem ? Explain.
30. **Case Based**

Read and observe the following to answer questions given

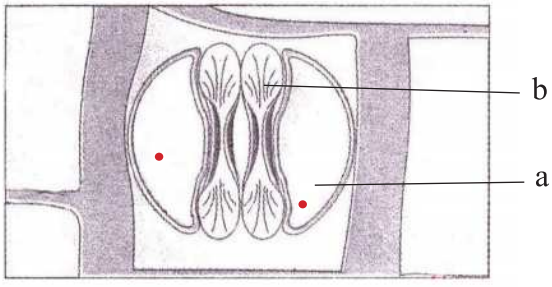
Stomata are present in the epidermis of leaves, to regulate transpirationo also are responsible for gas exchage. The can be dumb bell or kidney shaped stomatal appratus is made of stomatal aperature, guard cells and surrounding subsidiary cells.

Observe the figure and answer the following questions :

(i) Name parts (a) and (b).

(ii) Are these types of stomata observed in monocot or in dicot plants ?

(iii) Which parts shown in figure constitute the stomatal apparatus ?



Long Answer Questions (5 marks each)

31. (i) What are meristems ?

(ii) Name the various kinds of meristems in plants.

(iii) State the location and functions of meristems.

Assertion and Reason Based

DIRECTIONS: In the following questions, a statement of assertion(A) is followed by a statement of the reason(R). mark the correct choice as :

(a) If both (A) and (R) are correct and (R) is the correct explanation of (A).

(b) If both (A) and R are true, but (R(is not the correct explanation of (A).

(c) If (A) is true but (R) is false.

(d) If both (A) and (R) are false.

32. Assertion : Apical meristem of the root is subterminal.
Reason : At the terminal end of the root, the root cap is present.
33. Assertion : Aerenchyma helps to maintain buoyancy in hydrophyte plants.
Reason : The large air chambers are present in aerenchyma.
34. Assertion : A simple tissue is made of a single type of cells.
Reason : Various simple tissues are parenchyma, collenchyma and sclerenchyma.

Answers

(SRT) Select Response Type Question (1 mark each)

1. (c) Sclerenchyma 2. (a) Springwood
3. (b) Xylem combium & phloem

CONSTRUCTED RESPONSE TYPE (CRT)

Very Short Answers (1 mark each)

4. Pith stores the food material.
5. Bulliform cells are found in the upper epidermis of monocot leaves.
6. As they are made up of more than one kind of cells.
7. Primary meristem.
8. Fascicular and intrafascicular strips of meristem.
9. Pericycle of mature zone.
10. Mesophyll tissue.
11. Collenchyma.
12. Lateral conduction of food and supply of water from xylem.
13. Bulliform or motor cells.
14. Permit exchange of gases.
15. Bundle sheath cells.
16. Casparian strips are found in endodermis and make them water impermeable.
17. Maintain pressure gradient in sieve tubes.

Short Answers (SA-I) (2 marks each)

18. The cambium is considered as a lateral meristem because it occurs along the lateral sides of the stem and roots and appears later than primary meristem. Cells of this meristem divide periodically and increase the thickness of the plant body.

19.

Tracheid	Vessels
1. A tracheid is formed from a single cell.	1. A vessel is made of a number of cells.
2. The ends are oblique or tapering.	2. The ends are rounded and transverse.
3. They are comparatively narrower.	3. They are comparatively wider
4. The lumen is narrower.	4. The lumen is wide.
5. Septa remain intact	5. Septa lacking

20. **Open Vascular bundles :** These vascular bundles contain a strip of cambium in between phloem and xylem. Open vascular bundles are collateral and bicollateral.

    Closed Vascular bundles : Intrafascicular cambium is absent. Closed vascular bundles can be collateral or concentric.

21. Trichomes are multicellular epidermal hairs on the stem, seeds or fruits. Trichomes help in protection, dispersal of fruits and seeds and reduction in water loss.

22. (b) Sclerenchyma : photosynthesis, storage and secretion is not a matching pair. The function of sclerenchyma is to provide mechanical support to organs.

23. (a) Root (b) Monocot root

Short Answers (SA-II) (3 marks each)

24. **Lenticels :** Opening that are found in old stems and roots in the cork tissues containing a number of complimentary cells and they are permanently opened pores.

    Stomata : Opening that are found in leaves and young stems in the epidermis and have two guard cells. They open and close in response to turgidity of their guard cells.

25. Palms possess residual meristem below their leaf primordial, which adds ground parenchyma and vascular bundles. The ground parenchyma can also undergo further divisions even after the completion of elongation.

26.

Endarch condition	Exarch condition
1. Protoxylem towards pith and metaxylem towards periphery 2. Found in Stem	1. Protoxylem towards periphery and metaxylem towards pith 2. Found in root.

27. **Meristematic tissues** are composed of cells that have the capability to divide. These cells exist in different shapes without intercellular space. Cells are thin walled, rich in protoplasm, without vacuoles.

Permanent tissues are derived from meristematic tissue and are composed of cells with definite shape, size and function. These cells may be thin walled (living) or thick walled (dead).

28.

Aerenchyma	Collenchyma
(a) Parenchymatous tissue containing large air space. (b) Thin walled cells, isodiametric in in shape with intercellular space. (c) Provides buoyancy to the plant.	(a) Tissue contains deposits of cellulose and large pectin at the corner of cells. (b) Consists of oval and polygonal cells without intercellular space. (c) Provides elasticity and mechanical strength.

29. (a) The sieve elements of phloem is comparable to the vessel of the xylem because both lack nucleus.
(b) Pholem fibre is similar to the xylem fibre because both provide tensile strength to the tissue.
(c) Phloem parenchyma and xylem parenchyma is the living components of phloem and xylem respectively.

30. (i) a : epidermal cell b : guard cell
(ii) In monocot plants.
(iii) The stomatal apparatus includes the stomatal aperture, guard cells and the surrounding subsidiary cells.

Long Answers (5 mark each)

31. (i), (ii) and (iii) : Refer 'Points to remember'

32. (a) 33. (c) 34. (b)